

Water Quality Modeling in Puget Sound

Gaps in Model Development and Monitoring

Development Gaps

- 1) Current biogeochemical models (PSGB and South Sound) can simulate main basins with reasonable accuracy but not shallow basins and portions of Hood Canal. Accurate analysis of these areas is within reach but will require additional model development, including development of refined model grids and inputs. Candidates for future development work include incorporation of sediment diagenesis subroutines into existing models, addition of submerged aquatic vegetation, and sediment toxics modules.
- 2) The MoSSea Salish Sea model is a circulation-only model at this time and is not funded to incorporate biogeochemistry. Porting the MoSSea coastal water quality model to the MoSSea Salish Sea simulation would give us two water quality models (PSGB and MoSSea) of the entire Salish Sea that can be systematically compared to identify relative strengths and areas of potential improvement. In addition, this capability puts UW in a position to pursue water quality modeling-related grant funding from sources not available to Ecology.
- 3) Current models do not simulate pH and carbon chemistry. Analysis of acidification and the relationship between local nutrient/carbon inputs and global CO₂ influence in Puget Sound will require additional model development.
- 4) Model updates and improvement over time. For example, continue priority improvements in the models, such as adding new parameters not currently simulated (e.g., suspended solids/turbidity, zooplankton), improved boundary conditions (e.g., Johnstone Strait representation at northern Salish Sea boundary), and model parameter re-calibration.
- 5) Maintain model diversity. The expertise of the Ecology/PNNL and UW Oceanography teams encompasses key areas of study, including nearshore dynamics, water quality/chemistry, plankton biology and coastal/estuarine physics). It is crucially important that there be several active modeling groups in the region.
- 6) The Atlantis model has the potential to be integrated with the biogeochemical models (e.g., PSGB and MoSSea). The circulation models must be spatially integrated to match the geometry of the Atlantis grid cells. Other basic needs for Atlantis include: a dedicated technician to lead literature and database searches and continue parameter development, additional computing resources, and code additions to address issues such as hypoxia, ocean acidification, or contaminant concentrations.

Monitoring Data Needs

Existing long term monitoring programs for Puget Sound marine waters and major tributaries are providing a reasonable information base for model development, but there are important gaps that increase uncertainty and error in the biogeochemical models, including:

- 1) Oceanic boundary monitoring. The temporal and spatial resolution of this monitoring is critical to accurately simulating conditions in the interior of Puget Sound. Areas of interest include Strait of Juan de Fuca and Johnstone Strait. Model quality is affected by limited frequency, spatial coverage, and parameter list monitored by current buoy systems.
- 2) New, limited-term biological process studies in Puget Sound would reduce uncertainty in biogeochemical predictions: phytoplankton response to temperature, light, nutrients; grazer community composition over the season cycle; carbon and nutrient fluxes from the surface layer to the benthos.
- 3) Limited-term studies of sediment oxygen demand and chemical flux. Models are generally showing sensitivity to sediment conditions and processes. There is a need to expand the current base of information on sediment oxygen demand and fluxes of ammonia and nitrate.
- 4) ORCA buoy monitoring. These specialized buoys provide high temporal resolution information for areas of interest. In particular they are crucial for temporal resolution of plankton blooms, which develop in 1-2 days, and may easily be missed by monthly sampling. Past deployment has been project-based but there is pending discussion of potential long term siting and operation.
- 5) Food web monitoring. Each modeled functional group requires (at a minimum) estimates of biomass, production or mortality rate, consumption rate, diet, and fishing mortality rates. Key areas include: zooplankton, demersal and forage fish, and seasonal diets for most consumers. May also include stable isotopes of N, C, and S.
- 6) Toxics monitoring to increase confidence in box model predictions of environmental concentrations in water, sediment, and biota. Needs include trends in toxics loading from major rivers, toxics concentration in suspended sediment in Puget Sound, toxics loading from direct groundwater, confirmation of PCB and PBDE concentrations at the ocean boundary, trends in atmospheric deposition, and fate/transport/bioaccumulation within freshwater tributaries to the Sound.
- 7) Other monitoring, including:
 - Nearshore/Estuarine conditions
 - Weather – additional stations to assess spatial variability and accuracy of weather models